

2. The method of claim 1 wherein said oxidizing reagent is selected from the group consisting of potassium peroxomonosulfate, sodium hypochlorite, sodium perborate, hydrogen peroxide, and peracids.

3. The method of claim 2 wherein said epoxidation reaction is carried out using potassium peroxomonosulfate as an oxidizing agent.

4. The method of claim 1 wherein said epoxidation reaction is carried out in a homogeneous solvent system containing dimethoxymethane-acetonitrile-water, acetonitrile-water, acetone-water, dioxane-water, dimethoxyethane-water, tetrahydrofuran-water, or a biphasic solvent system containing dichloromethane-water, chloroform-water, benzene-water, toluene-water, dimethoxymethane-water, or diethylether-water, or mixtures thereof.

5. The method of claim 1 wherein said epoxidation reaction is carried out at a temperature within the range from about -10°C to about 40°C .

6. The method of claim 5 wherein said epoxidation reaction is carried out at room temperature.

7. The method of claim 1 wherein said epoxidation reaction is carried out at a pH within the range from about 7.0 to about 12.0.

8. The method of claim 7 wherein said pH is within the range from about 7.0 to about 7.5.

10. The method of claim 9 wherein said buffer is selected from the solutions consisting of sodium bicarbonate, sodium carbonate, sodium borate, sodium hydrogenphosphate, sodium dihydrogenphosphate, sodium hydroxide, potassium hydrogenphosphate, potassium dihydrogenphosphate, potassium bicarbonate, potassium carbonate, potassium hydroxide, or mixtures thereof.

11. The method of claim 1 wherein said epoxidation reaction provides said epoxides in at least about 5:1 β/α -epoxide ratio.

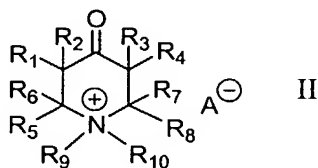
12. A method of producing mostly 5 β ,6 β -epoxides of steroids from Δ^5 -unsaturated steroids having a substituent at the 3 α -position by an epoxidation reaction using a ketone and an oxidizing agent under conditions effective to generate epoxides.

13. The method of claim 12 wherein said substituent is selected from OR (where R = H, alkyl or aryl), O(CH₂)_nOR (where n = 1, 2 or 3, R = H, alkyl or aryl), O(CH₂)_mSO_nR (where n = 1, 2 or 3; m = 0, 1 or 2; R = H, alkyl or aryl), OSiR₁R₂R₃ (where R₁, R₂ or R₃ = alkyl or aryl), OSO_nR (where n = 0, 1 or 2; R = H, alkyl or aryl), OCO_nR (where n = 1 or 2; R = H, alkyl or aryl), OCONR₁R₂ (where R₁ or R₂ = H, alkyl or aryl), OPO_nR (where n = 2 or 3; R = alkyl or aryl), NR₁R₂ (where R₁ or R₂ = H, alkyl or aryl), NR₁CO_nR₂ (where n = 1 or 2; R₁ or R₂ = H, alkyl or aryl), NR₁CONR₂R₃ (where R₁, R₂ or R₃ = H, alkyl or aryl), NR₁SO_nR₂ (where n = 1 or 2; R₁ = H, alkyl or aryl, R₂ = alkyl or aryl), NPhth (Phth = phthaloyl group), ⁺NR₁R₂R₃ (where

R_1 , R_2 , or R_3 = H, alkyl or aryl), $SiR_1R_2R_3$ (where R_1 , R_2 , or R_3 = H, alkyl or aryl), SO_nR (where n = 0, 1 or 2; R = H, alkyl or aryl), SCO_nR (where n = 1 or 2; R = H, alkyl or aryl), halogen, CN, NO_2 , alkyl, aryl, $COOR$ (where R = H, alkyl or aryl), and $CONR_1R_2$ (where R_1 or R_2 = H, alkyl or aryl).

14. The method of claim 12 wherein said Δ^5 -unsaturated steroid having a substituent at the 3α -position is selected from the group consisting of Δ^5 -unsaturated steroids having a ketal derivative of ketone group or a thioketal derivative of ketone group at the 3-position.

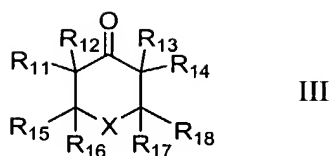
15. The method of claim 12 wherein said ketone is selected from the group consisting of compounds of generic formula II, III, IV, and V wherein



R_1 , R_2 , R_3 , or R_4 in formula (II) is selected from H, alkyl, halogenated alkyl, aryl, OR (where R = H, alkyl or aryl), $OCOR$ (where R = H, alkyl or aryl), $OCOOR$ (where R = alkyl or aryl), $CONR_1R_2$ (where R_1 or R_2 = H, alkyl or aryl), $OSiR_1R_2R_3$ (where R_1 , R_2 or R_3 = alkyl or aryl), and halogen;

R_5 , R_6 , R_7 , R_8 , R_9 or R_{10} in formula (II) is selected from H, alkyl, halogenated alkyl, aryl, $COOR$ (where R = H, alkyl or aryl), and $CONR_1R_2$ (where R_1 or R_2 = H, alkyl or aryl);

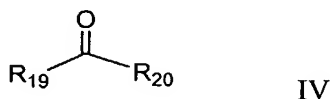
A in formula (II) is selected from halogen, OTf, BF_4 , OAc, NO_3 , BPh_4 , PF_6 , and SbF_6 ;



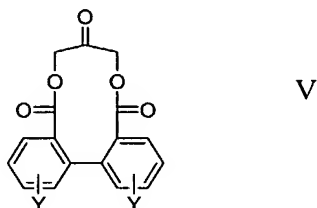
X in formula (III) is selected from $(CR_1R_2)_n$ (where $n = 1, 2, 3, 4, \text{ or } 5$; R_1 or $R_2 = H$, alkyl or aryl), O, S, SO, SO₂, and NR (where $R = H$, alkyl or aryl);

$R_{11}, R_{12}, R_{13}, \text{ or } R_{14}$ in formula (III) is selected from H, alkyl, halogenated alkyl, aryl, OR (where $R = H$, alkyl or aryl), OCOR (where $R = H$, alkyl or aryl), OCOOR (where $R = \text{alkyl or aryl}$), OCONR₁R₂ (where R_1 or $R_2 = H$, alkyl or aryl), OSiR₁R₂R₃ (where $R_1, R_2 \text{ or } R_3 = \text{alkyl or aryl}$), and halogen;

$R_{15}, R_{16}, R_{17}, \text{ or } R_{18}$ in formula (III) is selected from H, alkyl, halogenated alkyl, aryl, COOR (where $R = H$, alkyl or aryl), and CONR₁R₂ (where R_1 or $R_2 = H$, alkyl or aryl);



R_{19} or R_{20} in formula (IV) is selected from alkyl, halogenated alkyl, aryl, CR₁R₂OCOR₃ (where $R_1, R_2 \text{ or } R_3 = H, \text{ alkyl or aryl}$), CR₁R₂OCOOR₃ (where $R_1 \text{ or } R_2 = H, \text{ alkyl or aryl}$; $R_3 = \text{alkyl or aryl}$), CR₁R₂NR₃COOR₄ (where $R_1, R_2 \text{ or } R_3 = H, \text{ alkyl or aryl}$, $R_4 = \text{alkyl or aryl}$), CR₁R₂NR₃COR₄ (where $R_1, R_2, R_3 \text{ or } R_4 = H, \text{ alkyl or aryl}$), and CR₁R₂NR₃SO₂R₄ (where $R_1, R_2 \text{ or } R_3 = H, \text{ alkyl or aryl}$; $R_4 = \text{alkyl or aryl}$); and



Y in formula (V) is selected from H, alkyl, halogenated alkyl, aryl, NO₂, CN, F, Cl, Br, I, COOR (where $R = H \text{ or alkyl}$), OR (where $R = H, \text{ alkyl or aryl}$), OSO₂R (where $R = H, \text{ alkyl or aryl}$), and

aryl), OSOR (where R = H, alkyl or aryl), OSR (where R = H, alkyl or aryl), SO₂R (where R = H, alkyl or aryl), SO₃R (where R = H, alkyl or aryl), SOON R₁R₂ (where R₁ or R₂ = H, alkyl or aryl), NR₁SOOR₂ (where R₁ = H, alkyl or aryl; R₂ = alkyl or aryl), NR₁SOR₂ (where R₁ = H, alkyl or aryl; R₂ = alkyl or aryl), CR₁R₂OR₃ (where R₁, R₂ or R₃ = H, alkyl or aryl), CR₁(OR₂)₂ (where R₁ = H or alkyl; R₂ = alkyl), CF₃, CF₂CF₃, OTf, OTs, OCOR (where R = H, alkyl or aryl), and OSiR₁R₂R₃ (where R₁, R₂ or R₃ = alkyl or aryl).

16. The method of claim 12 wherein said epoxidation reaction is carried out in a homogeneous solvent system containing dimethoxymethane-acetonitrile-water, acetonitrile-water, acetone-water, dioxane-water, dimethoxyethane-water, tetrahydrofuran-water, or a biphasic solvent system containing dichloromethane-water, chloroform-water, benzene-water, toluene-water, dimethoxymethane-water, or diethylether-water, or mixtures thereof.

17. The method of claim 12 wherein said oxidizing reagent is selected from the group consisting of potassium peroxomonosulfate, sodium hypochlorite, sodium perborate, hydrogen peroxide, and peracids.

18. The method of claim 17 wherein said epoxidation reaction is carried out using potassium peroxomonosulfate as an oxidizing agent.

19. The method of claim 12 wherein said epoxidation reaction is carried out at a temperature within the range from about -10 °C to about 40 °C.

R₁ or R₄ in formula (I) is selected from alkyl, halogenated alkyl, aryl, OR (where R = H, alkyl or aryl), OCOR (where R = H, alkyl or aryl), OCOOR (where R = alkyl or aryl), OCOOCH₂R (where R = aryl), OCONR₁R₂ (where R₁ or R₂ = H, alkyl or aryl), OSiR₁R₂R₃ (where R₁, R₂ or R₃ = alkyl or aryl), and halogen;

R₂ or R₃ in formula (I) is selected from H, alkyl, halogenated alkyl, aryl, OR (where R = H, alkyl or aryl), OCOR (where R = H, alkyl or aryl), OCOOR (where R = alkyl or aryl), OCOOCH₂R (where R = aryl), OCONR₁R₂ (where R₁ or R₂ = H, alkyl or aryl), OSiR₁R₂R₃ (where R₁, R₂ or R₃ = alkyl or aryl), and halogen;

R₅, R₆, R₇ or R₈ in formula (I) is selected from H, alkyl, halogenated alkyl, aryl, COOR (where R = H, alkyl or aryl), and CONR₁R₂ (where R₁ or R₂ = H, alkyl or aryl);

R₉ or R₁₀ in formula (I) is selected from alkyl, halogenated alkyl, and aryl; and

A in formula (I) is selected from halogen, OTf, BF₄, OAc, NO₃, BPh₄, PF₆, and SbF₆.

28. The method of claim 26 wherein said epoxidation reaction is carried out in a solvent selected from acetonitrile, dimethoxymethane, acetone, dioxane, dimethoxyethane, tetrahydrofuran, dichloromethane, chloroform, benzene, toluene, diethylether, water, and mixtures thereof.

29. The method of claim 26 wherein said epoxidation reaction is carried out at a temperature within the range from about -40°C to about 40°C .

30. The method of claim 26 wherein said epoxidation reaction is carried out at a pH within the range from about 7.0 to about 12.0.

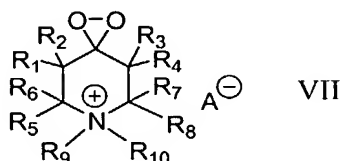
31. The method of claim 26 wherein said epoxidation reaction provides said epoxides in at least about 5:1 β/α -epoxide ratio.

32. A method of producing mostly 5 β ,6 β -epoxides of steroids from Δ^5 -unsaturated steroids having a substituent at the 3 α -position by an epoxidation reaction using a dioxirane under conditions effective to generate epoxides.

33. The method of claim 32 wherein said substituent is selected from OR (where R = H, alkyl or aryl), O(CH₂)_nOR (where n = 1, 2 or 3, R = H, alkyl or aryl), O(CH₂)_mSO_nR (where n = 1, 2 or 3; m = 0, 1 or 2; R = H, alkyl or aryl), OSiR₁R₂R₃ (where R₁, R₂ or R₃ = alkyl or aryl), OSO_nR (where n = 0, 1 or 2; R = H, alkyl or aryl), OCO_nR (where n = 1 or 2; R = H, alkyl or aryl), OCONR₁R₂ (where R₁ or R₂ = H, alkyl or aryl), OPO_nR (where where n = 2 or 3; R = alkyl or aryl), NR₁R₂ (where R₁ or R₂ = H, alkyl or aryl), NR₁CO_nR₂ (where n = 1 or 2; R₁ or R₂ = H, alkyl or aryl), NR₁CONR₂R₃ (where R₁, R₂ or R₃ = H, alkyl or aryl), NR₁SO_nR₂ (where n = 1 or 2; R₁ = H, alkyl or aryl, R₂ = alkyl or aryl), NPhth (Phth = phthaloyl group), ⁺NR₁R₂R₃ (where R₁, R₂, or R₃ = H, alkyl or aryl), SiR₁R₂R₃ (where R₁, R₂, or R₃ = H, alkyl or aryl), SO_nR (where n = 0, 1 or 2; R = H, alkyl or aryl), SCO_nR (where n = 1 or 2; R = H, alkyl or aryl), halogen, CN, NO₂, alkyl, aryl, COOR (where R = H, alkyl or aryl), and CONR₁R₂ (where R₁ or R₂ = H, alkyl or aryl).

34. The method of claim 32 wherein said Δ^5 -unsaturated steroid having a substituent at the 3 α -position is selected from the group consisting of Δ^5 -unsaturated steroids having a ketal derivative of ketone group or a thioketal derivative of ketone group at the 3-position.

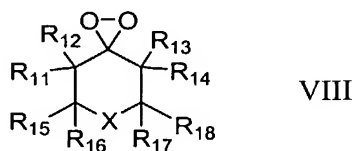
35. The method of claim 32 wherein said dioxirane is selected from the group consisting of compounds of generic formula VII, VIII, IX and X.



R_1 , R_2 , R_3 , or R_4 in formula (VII) is selected from H, alkyl, halogenated alkyl, aryl, OR (where R = H, alkyl or aryl), OCOR (where R = H, alkyl or aryl), OCOOR (where R = alkyl or aryl), OCOOCH₂R (where R = aryl), OCONR₁R₂ (where R₁ or R₂ = H, alkyl or aryl), OSiR₁R₂R₃ (where R₁, R₂ or R₃ = alkyl or aryl), and halogen;

R_5 , R_6 , R_7 , R_8 , R_9 or R_{10} , in formula (VII) is selected from H, alkyl, halogenated alkyl, aryl, COOR (where R = H, alkyl or aryl), and CONR₁R₂ (where R₁ or R₂ = H, alkyl or aryl);

A in formula (VII) is selected from halogen, OTf, BF₄, OAc, NO₃, BPh₄, PF₆, and SbF₆;

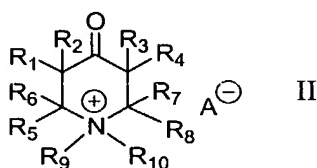


X in formula (VIII) is selected from (CR₁R₂)_n (where n = 1, 2, 3, 4, or 5; R₁ or R₂ = H, alkyl or aryl), O, S, SO, SO₂, and NR (where R = H, alkyl or aryl);

R_{11} , R_{12} , R_{13} , or R_{14} in formula (VIII) is selected from H, alkyl, halogenated alkyl, aryl, OR (where R = H, alkyl or aryl), OCOR (where R = H, alkyl or aryl), OCOOR (where R = alkyl

36. The method of claim 32 wherein said dioxirane is generated in situ from a ketone and an oxidizing agent selected from potassium peroxomonosulfate, sodium hypochlorite, sodium perborate, hydrogen peroxide, and peracids.

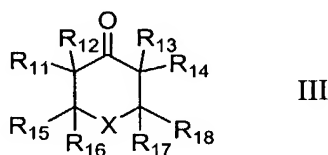
37. The method of claim 36 wherein said ketone is selected from the group consisting of compounds of generic formula II, III, IV, and V,



R_1 , R_2 , R_3 , or R_4 in formula (II) is selected from H, alkyl, halogenated alkyl, aryl, OR (where $R = H$, alkyl or aryl), OCOR (where $R = H$, alkyl or aryl), OCOOR (where $R = \text{alkyl or aryl}$), OCOOCH₂R (where $R = \text{aryl}$), OCONR₁R₂ (where R_1 or $R_2 = H$, alkyl or aryl), OSiR₁R₂R₃ (where R_1 , R_2 or $R_3 = \text{alkyl or aryl}$), and halogen;

R_5 , R_6 , R_7 , R_8 , R_9 or R_{10} in formula (II) is selected from H, alkyl, halogenated alkyl, aryl, COOR (where $R = H$, alkyl or aryl), and CONR₁R₂ (where R_1 or $R_2 = H$, alkyl or aryl);

A in formula (II) is selected from halogen, OTf, BF₄, OAc, NO₃, BPh₄, PF₆, and SbF₆;

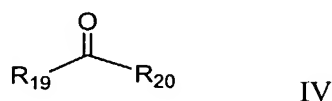


X in formula (III) is selected from (CR₁R₂)_n (where $n = 1, 2, 3, 4$, or 5 ; R_1 or $R_2 = H$, alkyl or aryl), O, S, SO, SO₂, and NR (where $R = H$, alkyl or aryl);

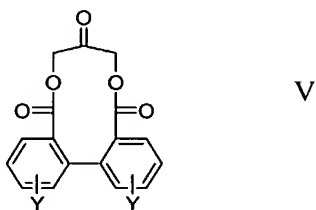
R_{11} , R_{12} , R_{13} , or R_{14} in formula (III) is selected from H, alkyl, halogenated alkyl, aryl, OR (where $R = H$, alkyl or aryl), OCOR (where $R = H$, alkyl or aryl), OCOOR (where $R = \text{alkyl or aryl}$),

aryl), OCOOCH_2R (where $\text{R} = \text{aryl}$), OCONR_1R_2 (where R_1 or $\text{R}_2 = \text{H}$, alkyl or aryl), $\text{OSiR}_1\text{R}_2\text{R}_3$ (where R_1 , R_2 or $\text{R}_3 = \text{alkyl}$ or aryl), and halogen;

R_{15} , R_{16} , R_{17} , or R_{18} in formula (III) is selected from H, alkyl, halogenated alkyl, aryl, COOR (where $\text{R} = \text{H}$, alkyl or aryl), and CONR_1R_2 (where R_1 or $\text{R}_2 = \text{H}$, alkyl or aryl);



R_{19} or R_{20} in formula (IV) is selected from alkyl, halogenated alkyl, aryl, $\text{CR}_1\text{R}_2\text{OCOR}_3$ (where R_1 , R_2 or $\text{R}_3 = \text{H}$, alkyl or aryl), $\text{CR}_1\text{R}_2\text{OCOOR}_3$ (where R_1 or $\text{R}_2 = \text{H}$, alkyl or aryl; $\text{R}_3 = \text{alkyl}$ or aryl), $\text{CR}_1\text{R}_2\text{NR}_3\text{COOR}_4$ (where R_1 , R_2 or $\text{R}_3 = \text{H}$, alkyl or aryl, $\text{R}_4 = \text{alkyl}$ or aryl), $\text{CR}_1\text{R}_2\text{NR}_3\text{COR}_4$ (where R_1 , R_2 , R_3 or $\text{R}_4 = \text{H}$, alkyl or aryl), $\text{CR}_1\text{R}_2\text{NR}_3\text{SO}_2\text{R}_4$ (where R_1 , R_2 or $\text{R}_3 = \text{H}$, alkyl or aryl; $\text{R}_4 = \text{alkyl}$ or aryl); and



Y in formula (V) is selected from H, alkyl, halogenated alkyl, aryl, NO_2 , CN , F , Cl , Br , I , COOR (where $\text{R} = \text{H}$ or alkyl), OR (where $\text{R} = \text{H}$, alkyl or aryl), OSO_2R (where $\text{R} = \text{H}$, alkyl or aryl), OSOR (where $\text{R} = \text{H}$, alkyl or aryl), OSR (where $\text{R} = \text{H}$, alkyl or aryl), SO_2R (where $\text{R} = \text{H}$, alkyl or aryl), SO_3R (where $\text{R} = \text{H}$, alkyl or aryl), $\text{SOON R}_1\text{R}_2$ (where R_1 or $\text{R}_2 = \text{H}$, alkyl or aryl), NR_1SOOR_2 (where $\text{R}_1 = \text{H}$, alkyl or aryl; $\text{R}_2 = \text{alkyl}$ or aryl), NR_1SOR_2 (where $\text{R}_1 = \text{H}$, alkyl or aryl; $\text{R}_2 = \text{alkyl}$ or aryl), $\text{CR}_1\text{R}_2\text{OR}_3$ (where R_1 , R_2 or $\text{R}_3 = \text{H}$, alkyl or aryl), $\text{CR}_1(\text{OR}_2)_2$ (where $\text{R}_1 = \text{H}$ or alkyl; $\text{R}_2 = \text{alkyl}$), CF_3 , CF_2CF_3 , OTf , OTs , OCOR (where $\text{R} = \text{H}$, alkyl or aryl), and $\text{OSiR}_1\text{R}_2\text{R}_3$ (where R_1 , R_2 or $\text{R}_3 = \text{alkyl}$ or aryl).

40. The method of claim 32 wherein said epoxidation reaction is carried out at a pH within the range from about 7.0 to about 12.0.

42. A method comprising:

XI

CH-1208635v1

R_1 in formula (XI) is selected from H, OR (where R = H or alkyl), OCOR (where R = alkyl or aryl), OCH_2OCH_3 , halogen, CF_3 , and CF_2CF_3 ;

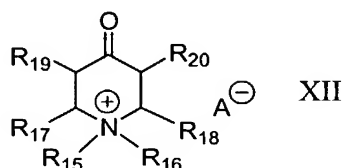
R_2 and R_3 in formula (XI) are each selected from the group consisting of H, alkyl, aryl, halogen, OR (where R = H or alkyl), OCOR (where R = alkyl or aryl), $OSiR_1'R_2'R_3'$ (where R_1' , R_2' or R_3' = alkyl or aryl), COR (where R = alkyl), $COCH_2OR$ (where R = H or alkyl), $COCH_2OCOR$ (where R = alkyl or aryl), $COCH_2F$, COOR (where R = H or alkyl), $C(OCH_2CH_2O)R$ (where R = alkyl), $C(OCH_2CH_2O)CH_2OR$ (where R = H or alkyl), $C(OCH_2CH_2O)CH_2OCOR$ (where R = alkyl or aryl), and $C(OCH_2CH_2O)CH_2F$; or, are selected from the group consisting of O, OCH_2CH_2O , and $OCH_2CH_2CH_2O$;

R_4 in formula (XI) is selected from H, C_1 – C_4 alkyl, halogen, OR (where R = H or alkyl), OCOR (where R = alkyl or aryl), and $OSiR_1'R_2'R_3'$ (where R_1' , R_2' or R_3' = alkyl or aryl);

R_5 in formula (XI) is selected from H, C_1 – C_4 alkyl, halogen, OR (where R = H or alkyl), OCOR (where R = alkyl or aryl), and $OSiR_1'R_2'R_3'$ (where R_1' , R_2' or R_3' = alkyl or aryl);

R_6 in formula (XI) is selected from H, halogen, OR (where R = H or alkyl), and OCOR (where R = alkyl or aryl);

R_7 in formula (XI) is selected from H, halogen, OR (where R = H or alkyl), and OCOR (where R = alkyl or aryl);



R_{15} and R_{16} in formula (XII) are each selected from alkyl and aryl;

R_{17} and R_{18} in formula (XII) are each selected from H, alkyl, aryl, COOR (where R = H, alkyl or aryl), and $CONR_1R_2$ (where R_1 or R_2 = H, alkyl or aryl);

R₁₉ and R₂₀ in formula (XII) are each selected from C₁–C₄ alkyl, halogenated alkyl, and halogen; and

A in formula (XII) is selected from OTf, BF₄, OAc, NO₃, BPh₄, PF₆, and SbF₆.

43. The method of claim 42 wherein said C₁–C₄ alkyl is selected from the group consisting of methyl, ethyl, normal-propyl, iso-propyl, normal-butyl, iso-butyl, sec-butyl, and tert-butyl; and said aryl selected from the group consisting of phenyl, substituted phenyl, naphthyl, and substituted naphthyl groups.

44. The method of claim 42 wherein said epoxidation reactions are carried out in a homogeneous solvent system selected from the group consisting of dimethoxymethane-acetonitrile-water, acetonitrile-water, acetone-water, dioxane-water, dimethoxyethane-water, tetrahydrofuran-water, and mixtures thereof.

45. The method of claim 42 wherein said epoxidation reactions are carried out in a biphasic solvent system selected from the group consisting of dichloromethane-water, chloroform-water, benzene-water, toluene-water, dimethoxymethane-water, or diethylether-water, and mixtures thereof.

46. The method of claim 42 wherein said oxidizing reagent is selected from the group consisting of potassium peroxomonosulfate, sodium hypochlorite, sodium perborate, hydrogen peroxide, and peracids.

47. The method of claim 42 wherein said epoxidation reactions are carried out at a temperature within the range from about -10 °C to about 40 °C.

48. The method of claim 47 wherein said epoxidation reactions are carried out at room temperature.

49. The method of claim 42 wherein said epoxidation reactions are carried out at a pH within the range from about 7.0 to about 12.0.

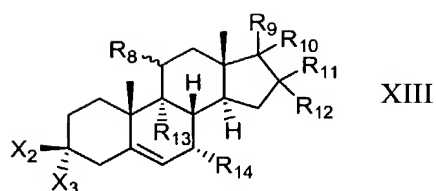
50. The method of claim 49 wherein said pH is within the range from 7.0 to 7.5.

51. The method of claim 49 wherein said pH is controlled by using a pH-stat or a buffer.

52. The method of claim 51 wherein said buffer is selected from the group consisting of sodium bicarbonate, sodium carbonate, sodium borate, sodium hydrogenphosphate, sodium dihydrogenphosphate, sodium hydroxide, potassium hydrogenphosphate, potassium dihydrogenphosphate, potassium bicarbonate, potassium carbonate, potassium hydroxide, or mixtures thereof.

53. A method comprising:

producing mostly 5 β ,6 β -epoxides of steroids by epoxidation reactions of Δ^5 -unsaturated steroids of generic formula XIII catalyzed by ketones of generic formula XIV, XV, XVI, and XVII, wherein



X_2 in formula (XIII) is selected from the group consisting of H, OR (where R = H or alkyl), OCH_2OCH_3 , OCOR (where R = alkyl or aryl), $OSiR_1'R_2'R_3'$ (where R_1' , R_2' or R_3' = alkyl or aryl), halogen, CN, alkyl, aryl, and COOR (where R = H, alkyl or aryl), and,

X_3 in formula (XIII) is selected from the group consisting of OR (where R = H or alkyl), OCH_2OCH_3 , OCOR (where R = alkyl or aryl), $OSiR_1'R_2'R_3'$ (where R_1' , R_2' or R_3' = alkyl or aryl), halogen, CN, NO_2 , alkyl, and aryl; or,

X_2 and X_3 in formula (XIII) are selected from the group consisting of O, OCH_2CH_2O , and $OCH_2CH_2CH_2O$;

R_8 in formula (XIII) is selected from H, OR (where R = H or alkyl), OCOR (where R = alkyl or aryl), OCH_2OCH_3 , halogen, CF_3 , and CF_2CF_3 ;

R_9 and R_{10} in formula (XIII) are each selected from the group consisting of H, alkyl, aryl, halogen, OR (where R = H or alkyl), OCOR (where R = alkyl or aryl), $OSiR_1'R_2'R_3'$ (where R_1' , R_2' or R_3' = alkyl or aryl), COR (where R = alkyl), $COCH_2OR$ (where R = H or alkyl), $COCH_2OCOR$ (where R = alkyl or aryl), $COCH_2F$, COOR (where R = H or alkyl), $C(OCH_2CH_2O)R$ (where R = alkyl), $C(OCH_2CH_2O)CH_2OR$ (where R = H or alkyl), $C(OCH_2CH_2O)CH_2OCOR$ (where R = alkyl or aryl), and $C(OCH_2CH_2O)CH_2F$; or R_9 and R_{10} in formula (XIII) are selected from the group consisting of O, OCH_2CH_2O , and $OCH_2CH_2CH_2O$;

R_{11} and R_{12} in formula (XIII) are each selected from the group consisting of H, C_1-C_4 alkyl, halogen, OR (where R = H or alkyl), OCOR (where R = alkyl or aryl), and $OSiR_1'R_2'R_3'$ (where R_1' , R_2' or R_3' = alkyl or aryl);

$\frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2}$



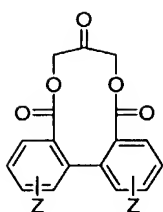
A in formula (XIV) is selected from OTf, BF₄, OAc, NO₃, BPh₄, PF₆, and SbF₆;



R₂₃ or R₂₄ in formula (XV) is selected from H, halogen, C₁-C₄ alkyl, halogenated alkyl, and OCOR (where R = alkyl or aryl);



R₂₅ or R₂₆ in formula (XVI) is selected from C₁–C₄ alkyl, halogenated alkyl, CH₂OCOR



XVII

Z in formula (XVII) is selected from H, C₁–C₄ alkyl, aryl, NO₂, CN, F, Cl, Br, I, COOR (where R = alkyl), CH₂OR (where R = H or alkyl), CH(OR)₂ (where R = alkyl), CF₃, CF₂CF₃, OTf, OTs, OCOR (where R = alkyl or aryl), and OSiR₁'R₂'R₃' (where R₁', R₂' or R₃' = alkyl or aryl).

54. The method of claim 53 wherein said C₁–C₄ alkyl is selected from the group consisting of methyl, ethyl, normal-propyl, iso-propyl, normal-butyl, iso-butyl, sec-butyl, and tert-butyl; and said aryl selected from the group consisting of phenyl, substituted phenyl, naphthyl, and substituted naphthyl groups.

55. The method of claim 53 wherein said epoxidation reactions are carried out in a homogeneous solvent system selected from the group consisting of dimethoxymethane-acetonitrile-water, acetonitrile-water, acetone-water, dioxane-water, dimethoxyethane-water, and tetrahydrofuran-water, and mixtures thereof.

56. The method of claim 53 wherein said epoxidation reactions are carried out in a biphasic solvent system selected from the group consisting of dichloromethane-water, chloroform-water, benzene-water, toluene-water, dimethoxymethane-water, or diethylether-water, and mixtures thereof.

